


Green Power Superhighways

Building a Path to America's Clean Energy Future

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AWEA American Wind Energy Association
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Executive Summary

The United States is home to vast quantities of clean energy resources – wind, solar, geothermal, and hydropower. Yet it lacks a modern interstate transmission grid to deliver carbon-free electricity to customers in highly populated areas of the country. President Obama has called for the United States to double the production of renewable energy in three years and to secure 25 percent of its electricity from renewable resources by 2025. Achieving this will require a cohesive effort from local, state, and federal officials and significant new investment in our transmission infrastructure. This paper will highlight the barriers that hinder investment in transmission infrastructure and identify potential policy solutions to overcome those barriers.

TRANSMISSION IS CRITICAL FOR RENEWABLE ENERGY

The massive deployment of renewable generation envisioned by President Obama cannot occur without a renewed investment in our country's transmission infrastructure. The U.S. Department of Energy (DOE) has identified transmission limitations as the greatest obstacle to realizing the enormous economic, environmental and energy security benefits of obtaining at least 20 percent of our electricity from the wind. Currently, almost 300,000 MW of wind projects, more than enough to meet 20 percent of our electricity needs, are waiting in line to connect to the grid because there is inadequate transmission capacity to carry the electricity they would produce. Concern about inadequate transmission is shared by the solar, geothermal, and hydropower industries as well. In California alone, more than 13,000 MW of large solar power plants are waiting to connect to the grid. Most of these projects will require new or significant upgrades to the existing transmission grid.

GREEN POWER SUPERHIGHWAYS

To promote the expansion of renewable energy, the transmission grid should be built to link areas with vast potential to generate clean electricity to the areas that have significant demand for electric power. "Green power superhighways" is a term to describe the power lines that would be carrying electricity from remote to populated areas. While any number of different build-out plans can be envisioned for green power superhighways, the key to any cost-effective plan is the use of high-voltage transmission lines in place of the low-voltage lines commonly deployed in the U.S. today.

CURRENT CHALLENGES

Policy barriers – not technical or economic barriers – are the chief factors impeding the construction of green power superhighways. However, there are notable changes that should be implemented to make better use of our transmission infrastructure.

Coordinating Regional Transmission Operations

Today's highly constrained patchwork transmission system makes it very difficult to move large amounts of renewable power around the country. A solution is to use the existing grid more efficiently through technology and new operating protocols. This is not a replacement for green power superhighways, but these changes would allow more wind and solar energy to be integrated with the grid at lower cost. Increased efficiency would provide greater flexibility for changes in electricity supply and demand and would improve economic performance of the grid even in the absence of renewable energy.

Recognizing the Consumer Benefits of Transmission

A robust transmission grid provides consumers with access to lower-cost electricity. On a severely constrained transmission grid, as now exists in many parts of the United States, consumers are forced to rely on local power plants even though plants in other regions can produce power more efficiently and at lower cost.

The effect of higher electricity prices goes beyond financial hardship for residential consumers. Businesses pass higher electricity costs on to their customers, and electricity-intensive industries have a strong incentive to relocate to regions with lower electricity costs, taking jobs with them.

New transmission infrastructure would increase competition in wholesale power markets. Just as consumers in a region with a single retailer and without high-quality roads to other regions would be at the mercy of the prices charged by that retailer, a weak grid makes it possible for power generation owners in constrained sections of the grid to raise prices beyond what they would be in a competitive market.

Recovering the Cost of Green Power Superhighways

Studies have consistently found that the costs of transmission investments needed to integrate wind power and other renewables are significantly outweighed by the consumer savings that those investments produce.

- A $50-60 billion investment in the transmission infrastructure to significantly reduce congestion and integrate 240 gigawatts (GW) of wind in the Eastern U.S. would reduce electricity costs by enough to fully offset the cost of the investment, according to a recent study conducted by the transmission grid operators in the Eastern U.S.
- The benefits of an investment in new transmission infrastructure for renewables would grow to be larger than the costs of the investment in less than three years, according to studies by the Electric Reliability Council of Texas (ERCOT).
- An investment in a high-voltage transmission overlay to access wind resources in Kansas, Oklahoma and Texas would provide economic savings of around $1 billion per year, more than twice the $400-500 million annual cost of the transmission investment, according to a recent analysis by Charles River Associates, International.

Reducing Land Use and Wildlife Impacts

Transmission, like all major infrastructure projects, will affect land use and wildlife, and advance planning is needed to minimize these impacts. High-capacity transmission lines reduce land impacts significantly compared with lower-voltage lines. Therefore, plans should be made to seek a long-term optimum transmission capacity from the start, especially since it is difficult to gain community support for an additional transmission line after an initial line has been built.

OUTMODED REGULATORY STRUCTURES NEED TO BE UPDATED

Although the benefits of transmission easily exceed its costs, few private firms have stepped forward to invest in transmission infrastructure. Why? Because the benefits of transmission are not adequately accounted for in the incentive structure offered to transmission investors. In other words, the existing regulatory structure often gives companies little or no economic incentive to invest in transmission that will make consumers and society as a whole better off.

State regulators, who in many areas have primary jurisdiction over what transmission gets built and who pays for it, are often required to weigh only the benefits that will accrue to residents of that state. Because the benefits of high-voltage transmission infrastructure typically accrue to millions of consumers over broad interstate regions, this process ignores a major portion of these benefits. Under this regulatory structure, it is almost impossible to build an interstate transmission network. Most state regulators have little authority or incentive to require ratepayers in their state to help pay for an interstate network.

Another major obstacle to transmission is that regulators in a single state can effectively veto a multi-state transmission network by refusing to grant the permits needed for siting a transmission line if they feel that their state would not receive an adequate share of the benefits of the project.

POLICY SOLUTIONS

To meet renewable portfolio standards, greenhouse gas reduction goals, and the public's demand for clean energy sources, a major investment in new transmission infrastructure is needed. Federal legislation is needed to provide new mission statements, adequate resources and specific timelines for action for federal agencies, such as DOE, the Federal Energy Regulatory Commission (FERC) and federal lands agencies. In particular, reform is needed in three broad areas:

Interconnection-Wide Transmission Planning

The first step in building green power superhighways is to develop a comprehensive plan. This requires both the Western Interconnection and the Eastern Interconnection to develop regional transmission plans that identify where new or expanded transmission capacity is necessary to connect renewable energy resources to the grid and, ultimately, to load centers.

Interconnection-Wide Transmission Cost Allocation and Certainty for Cost Recovery

Facilities identified in the interconnection-wide plan as necessary for the development of green power superhighways should be eligible for broad, regional cost allocation. Specifically, FERC should allocate, based on electricity usage, the capital and operating costs of these transmission lines across all load-serving entities on an interconnection-wide basis. In regulatory terms, the "determination of need" would be made in the regional plan, approved by FERC.

Federal Siting

In addition to regional planning and cost allocation, substantial reform of the transmission siting process is required to meet national renewable energy goals. The most effective model is the siting authority that was given to FERC over interstate natural gas pipelines. For green power superhighways, the extra-high-voltage facilities defined in the regional plans would be subject to FERC approval and permitting. Separate siting approval at the state level would not be required. FERC would act as the lead agency for purposes of coordinating all applicable federal authorizations and environmental reviews with other affected agencies.

THE ROAD FORWARD

Modernizing America's outdated transmission infrastructure will not be easy. It will require bold, forward-looking action from leaders who recognize that addressing America's economic, energy, and climate challenges must be a top priority in the coming years. All three challenges are intertwined. All three require new, innovative ways of thinking about energy policy at the local, state, and federal level. And all three will require a modern transmission system that is able to deliver clean, abundant renewable energy to homes and businesses efficiently and reliably. These are challenges that we can and must address now.

Introduction

The United States is home to vast quantities of clean energy resources – wind, solar, geothermal, and hydropower. Yet it lacks a modern interstate transmission grid to deliver carbon-free electricity to customers in highly populated areas of the country. President Obama has called on the country to double the amount of renewable energy produced in three years and to reach 25 percent of U.S. electricity from renewable sources by 2025. This will not be easy. It will take a cohesive effort from local, state, and federal officials to meet this challenge, and it cannot be accomplished without significant new investment in our transmission infrastructure. The time to act is now.

Green power superhighways, an interstate transmission system to deliver remote renewable electricity resources to population centers, would address many of the challenges facing our country. A more robust electric grid would allow plentiful domestic sources of renewable energy to be put to use powering our homes, schools, businesses, and even our vehicles, reducing carbon dioxide emissions as well as energy prices. Tapping the massive quantities of renewable resources that are typically stranded in our country's more remote areas would also cultivate economic development in regions where it is sorely needed. At a time of serious economic distress and mounting pressure to address the widespread environmental, economic, and geopolitical consequences of our excessive reliance on fossil fuels, green power superhighways are an integral solution to all of these problems.

From Roosevelt's New Deal to Eisenhower's interstate highway system, bold investments in infrastructure have often paved a way out of troubled times by building a foundation for economic growth. During the 1930s, the Rural Electrification Administration brought economic growth to the country's impoverished rural areas by electrifying rural farms and businesses. By making a renewed investment in electricity transmission infrastructure, rural regions' economies will again be revitalized as they begin to export one of their most valuable resources: clean, abundant renewable energy. Moreover, an investment in our grid is critical to realizing our nation's potential to create millions of high-paying "green collar" jobs by retaking the global lead in designing, building, and deploying the energy technologies of the 21st century.

This paper outlines clear steps policymakers can take to make green power superhighways a reality. Our nation's obsolete patchwork of an electric grid, while adequate for the era in which it was designed, is a direct product of the obsolete patchwork of policies, ownership, and regulation that currently govern it. The policies that govern how the transmission grid is planned, paid for, and permitted have failed to keep up with significant changes in the structure of the electric industry. Reforming these policies to create a more favorable environment for private and public investment in interstate transmission facilities is the most important step policymakers can take. As this paper will make clear, the benefits of green power superhighways outweigh the costs of investing in such a system. Section VIII of this paper outlines how these policies should be updated so that America can build a 21st century grid for 21st century challenges.

I. Transmission is Critical for Renewable Energy

The renewable energy industry cannot continue to grow without a renewed investment in our country's transmission infrastructure. In its recently released report, "20 Percent Wind Energy by 2030," the U.S. Department of Energy (DOE) identified transmission limitations as the largest obstacle to realizing the enormous economic, environmental, and energy security benefits of obtaining 20 percent of our electricity from the wind.[1] The renewable industry recognizes the primary importance of transmission as well: a poll conducted at the WINDPOWER 2008 Conference and Exhibition in June in Houston, Texas, found that participants saw transmission as the largest roadblock to the continued development of wind energy in the U.S.[2]

This level of concern is shared by members of the solar, geothermal, and hydropower industries as well. There are more than 4,000 megawatts (MW) of large solar power plants scheduled for construction in the next five years, most of which require new or significant upgrades to the existing transmission grid. The California Public Utilities Commission has identified lack of adequate transmission as the primary barrier utilities face in meeting their Renewable Portfolio Standard.[3] Even when the utilities have signed contracts with renewable generators, the lack of transmission can delay or prevent projects from being built. Similarly, the U.S. Bureau of Land Management has set a goal of developing 10,000 MW of renewable energy on federal lands by 2015.[4] However, this goal will not be met if the transmission grid does not reach those renewable generators.

The inadequacy of our country's transmission infrastructure is particularly burdensome for the development of wind, solar, hydroelectric, and geothermal energy because these resources tend to be located at a significant distance from population centers. The bulk of America's best wind resources are located in the plains stretching south from the Dakotas to Texas, while most of the country's population lives along the coasts. Similarly, the country's best geothermal and solar resources are located in remote regions of the Western U.S. Putting our country's vast renewable energy potential to use requires finding a way to move this electricity from where it will be generated to where it will be consumed.

Without a more robust transmission grid, our country will fail to realize the immense environmental, economic, and energy security benefits that would come from putting our country's renewable resources to use. The DOE's report estimated that obtaining 20 percent of U.S. electricity from wind would reduce carbon dioxide (CO_2) emissions by 7.6 billion tons between now and 2030. CO_2 emissions would be reduced by 825 million tons in the year 2030 alone, an amount equal to 25 percent of all electric sector CO_2 emissions in that year or the equivalent of taking 140 million cars off the road. These benefits stem from the fact that the use of renewable energy offsets the use of fossil fuels. The DOE study estimated that the 20 percent wind scenario would reduce electric sector coal use by 18 percent, electric sector natural gas use by 50 percent, and avoid the construction of 80,000 MW of new coal-fired power plants.[5] Similar penetrations of solar, geothermal, hydroelectric, and other renewable technologies would displace comparable amounts of emissions and fuel use – if this power can be transported to where it is needed.

Renewable energy also avoids the other harmful environmental effects of fossil fuel use, including emissions of SO_2, NO_X, mercury, and particulate matter; habitat destruction caused by the mining and drilling of fossil fuels; and massive water use in power plant cooling systems. In fact, DOE's report estimated that the 20 percent wind scenario would save 4 trillion gallons of water between now and 2030 by displacing power from fossil fuel plants with wind energy, with one-third of these water savings occurring in the arid West.

Within the environmental community, there is growing recognition that new transmission is critical to solving our pressing environmental problems. As the environmental group Western Resource Advocates concluded in their recent report, "Smart Lines: Transmission for the Renewable Energy Economy:"

> Efficiency and local generation won't be enough to satisfy future demand, let alone provide the capacity that will be needed to retire older coal facilities in order to make a dent in U.S. carbon emissions. Renewable energy at the utility scale will be required, and in the West, the resources that can provide this type of power are often far from population centers. That means significant new transmission capacity will be needed to tap these resources.[6]

A failure to invest in transmission will stunt the growth of one of the bright spots of the U.S. economy: the renewable energy industry. Continued growth of the renewable energy industry has the potential to create millions of high-paying, high-tech "green collar" jobs. Regaining American leadership in designing, manufacturing, and deploying renewable energy technologies is a powerful way to overcome the loss of domestic manufacturing jobs, as well as provide strong stimulus to help the U.S. economy recover from the current recession. A recent report by Navigant Consulting estimated that the solar industry can create 440,000 jobs and $325 billion in economic development over the next eight years.[7] DOE's 20 percent wind study also found significant economic benefits from putting our renewable resources to use. The 20 percent wind scenario would create over 500,000 jobs and $450 billion in economic impact by 2030, including billions in tax revenue for rural schools and lease payments to rural landowners and farmers.

In addition, it is estimated that the 50 percent reduction in electric sector natural gas use under the 20 percent wind energy scenario would save consumers $150 billion by decreasing the price of natural gas. Similarly, under a policy scenario in which CO_2 emissions are assigned a value of $15 per ton, the 7.6 billion tons of CO_2 emissions reductions achieved through the 20 percent wind scenario would have a value in excess of $100 billion.[8]

The growth of renewable energy is already being constrained by our country's antiquated electric grid. Currently, almost 300,000 MW of wind projects, more than enough to meet 20 percent of our electricity needs, are waiting in line to connect to the grid because there is inadequate transmission capacity to carry the electricity they would produce. The lack of transmission capacity is also hindering the ability of states and utilities to meet their renewable energy goals and standards. For example, even though California has excellent solar, geothermal, and wind resources, the state may fall short of meeting its 2010 renewable portfolio standard because it lacks the transmission infrastructure to bring these resources to market. As of January 2009, California had over 13,000 MW of wind plants and 30,000 MW of solar plants waiting to connect to the grid.[9] Similar backlogs exist in other regions, with 70,000 MW of wind projects waiting to interconnect in the upper Midwest, 40,000 MW in the lower Midwest, 40,000 MW in the Great Lakes/Mid-Atlantic, and 50,000 MW in Texas.[10]

Even wind projects that are already connected to the grid and operating are being hindered by the lack of sufficient transmission. In several regions of the country, zero-fuel cost wind power is regularly being curtailed at times of high output because there is inadequate transmission capacity to move this power to consumers and because there is no means to store this electricity. With many consumers paying record prices for electricity from fossil fuels and mounting concern about climate change, it makes little sense to waste zero-fuel cost, zero-emissions electricity. With renewable energy deployment expected to continue its rapid growth, curtailment of wind generators due to a lack of transmission capacity is only likely to worsen over the coming years. Given the long lead time for planning, siting, and building new transmission infrastructure, the time for action is now.

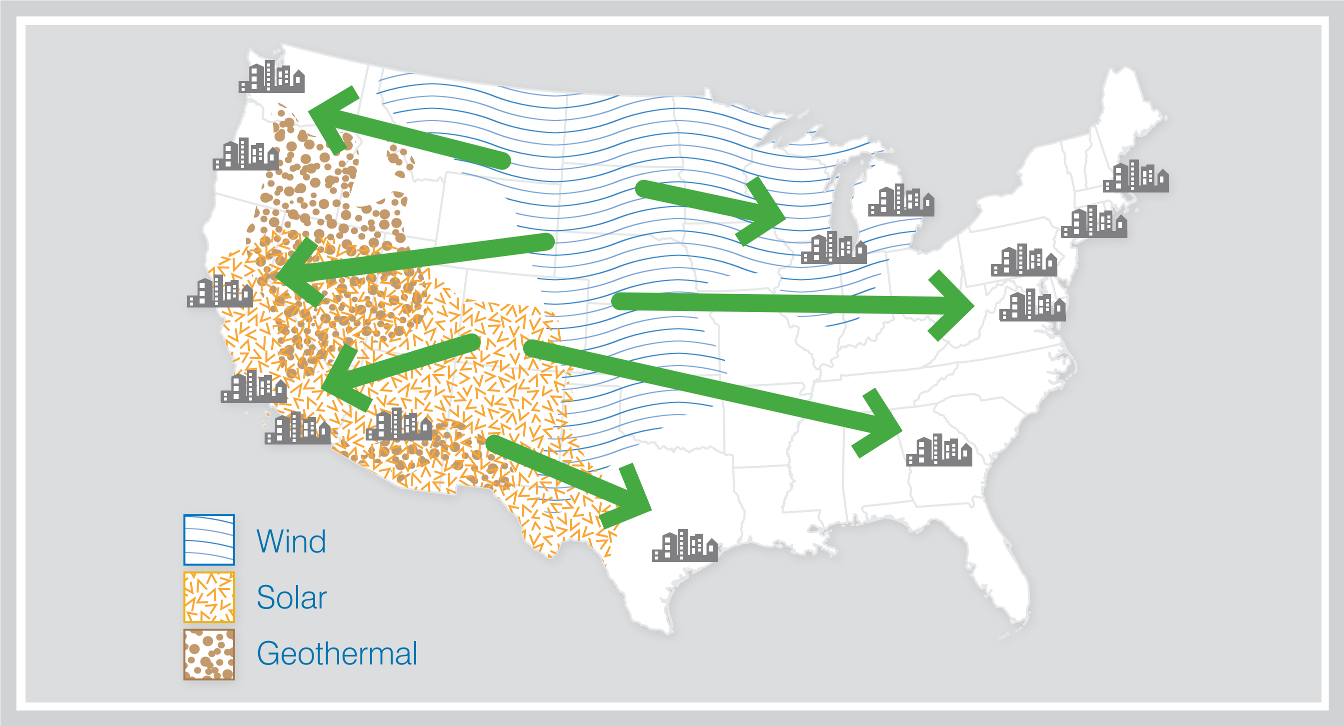
II. Green Power Superhighways

Green power superhighways would be designed to access renewable resources that are currently stranded in regions without adequate transmission capacity and deliver their electricity to demand centers. A conceptual vision of how nationwide green power superhighways would work is provided in Figure 1. Green power superhighways could allow other existing and new resources to use them, but they would be deliberately planned to access renewable energy resource areas while maintaining reliability and reducing costly congestion.

This plan is only conceptual and is not intended to advocate for a particular transmission pathway. There are a number potential transmission plans that would achieve the goal of integrating large amounts of renewable energy. Green power superhighways could include any combination of high-capacity Alternating Current (AC) and Direct Current (DC) lines, and it is not our intent to promote a specific technology in this paper. One conceptual vision of what a nationwide green power superhighway would look like was produced by American Electric Power (AEP) and AWEA.[11] The backbone of this plan is a network of 765-kV transmission lines that would provide enough transmission capacity to allow the U.S. to obtain 20 percent of its electricity from the wind, as well as accessing other renewable resources. Another study, the Joint Coordinated System Plan (JCSP) conducted by the major transmission operators in the Eastern U.S., produced a plan for a transmission network that uses seven 800-kV DC lines as well as a number of high-voltage AC lines to meet 20 percent of the region's electricity needs with wind energy by connecting windy areas in the Plains to population centers to the east.

While any number of different build-out plans can be envisioned for green power superhighways, the key to any cost-effective plan is the use of high-voltage transmission lines. Higher-voltage lines have a number of economic,

FIGURE 1: **Nationwide Green Power Superhighways: A Conceptual Vision**



Source: AWEA and SEIA

environmental, and efficiency benefits over the lower-voltage lines that are typically used in the U.S. today. The fundamental scientific reason for these benefits is that the electricity transmission capacity of a line is roughly proportional to the square of the voltage. As a result, a single 765-kV line can carry as much electricity as six 345-kV lines, reducing the amount of land needed by a factor of four. This has obvious benefits for easing the acquisition of right-of-way and for minimizing land use concerns about new transmission. In addition, higher voltage transmission lines are much more cost-effective than lower-voltage lines. Because of the economies of scale in building higher-voltage transmission, it costs two to three times as much to build 345-kV lines as it does to build 765-kV lines of equivalent capacity. These benefits are summarized in Figure 2 below.

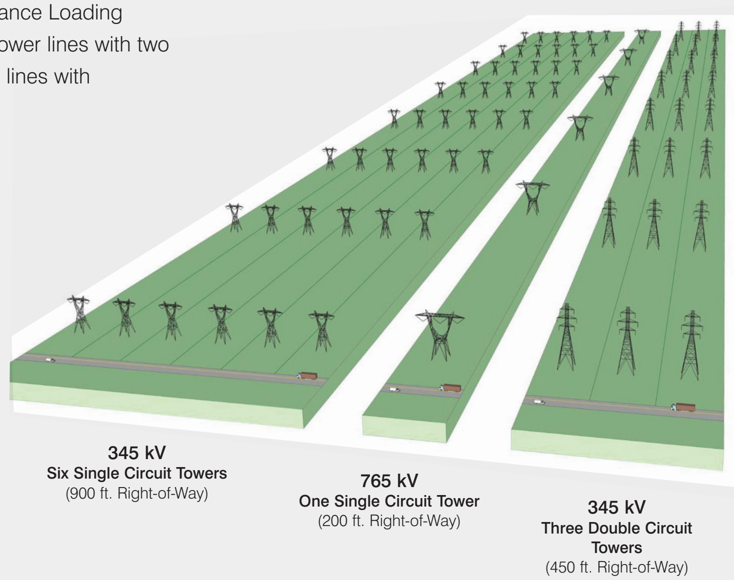
765-kV lines also typically have electricity losses that are 10 times lower than those from an equivalent capacity of 345-kV lines. Given that electricity losses are drastically higher on overloaded lower-voltage transmission lines, and that high-voltage lines offer the path of least resistance for electricity, the diversion of power flows to new high-voltage lines will significantly reduce congestion and thus losses on existing lines. As a result, a 765-kV grid overlay could reduce U.S. peak load electricity losses by 10 GW or more, the equivalent output of 20 typical 500 MW coal-fired power plants, and reduce annual CO_2 emissions by 16 million tons.[14]

Higher-voltage transmission is a proven technology. More than 2,000 miles of 765-kV transmission lines are currently operational in the U.S., and their reliability has consistently exceeded that of lower-voltage transmission lines over the 40-year period that these lines have been in service.[15] Higher-voltage transmission is becoming the standard around the world, with China and India planning to build 15 800-kV DC lines over the next decade.[16] As will be explained in Section VI, policy barriers – not technical or economic barriers – are the chief factors impeding the construction of green power superhighways.

FIGURE 2: **Economic and Land Use Benefits of High-Voltage Transmission**

NOTE: Approximate relationship based on Surge Impedance Loading (i.e. reactive power balance point) 345 kV single circuit tower lines with two conductors per phase compared to 765 kV single circuit lines with six conductors per phase.

Transmission Voltage (kV)	Cost per Mile ($/mile)	Capacity (MW)	Cost per Unit of Capacity ($/MW-mile)
230	$2.077 million	500	$5,460
345	$2.539 million	967	$2,850
500	$4.328 million	2040	$1,450
765	$6.578 million	5000	$1,320



(Sources: Edison Foundation[12], AEP[13])

III. More Efficient Use of the Existing Grid through Coordinated Regional Operations

There are a number of steps that can be taken to use the existing grid more efficiently through technology and new operations protocols. These are not replacements for green power superhighways; rather, in many cases they are also necessary to integrate variable resources such as wind and solar reliably into the power system. Wind and solar energy sources are generally not "dispatchable," i.e., available to be turned up or down in response to higher electrical demand.[17] Power system operations can be modified to allow for variable resources at different locations to offset each other, and to allow for better use of dispatchable generators and demand side resources to keep generation and load in balance. These reforms are highly cost-effective, and many of them would improve the efficiency and economic performance of the grid even in the absence of renewable energy. Introducing more coordinated and efficient regional grid operations in concert with building new transmission infrastructure would maximize the benefits for the economy, the environment, and our energy security.

Currently, the country's grid is divided into over 140 largely autonomous operating or "balancing" areas, ranging in size from less than 100 MW of peak demand to larger than 100,000 MW. Within each of these balancing areas, operators must constantly adjust the output of power plants to ensure that electricity supply and demand remain in near-perfect balance. Today, the transmission lines linking a balancing area with its neighbors are highly constrained. There is also a complex patchwork of transmission ownership. This makes it very difficult to move large amounts of renewable power around the country.

On top of this transmission infrastructure problem, in many regions power flows between balancing areas are arbitrarily limited by the balkanization of the grid into small balancing areas. For example, at any point in time one balancing area may have excess generation while an adjacent balancing area may have a generation shortfall. Under the current grid operating structure in much of the country, power plants in the first area would be required to decrease generation at the same time that power plants in the second are increasing their output. By better coordinating operations, excess power from the first area could simply be used to meet the shortfall in the second area, saving the potentially significant expense of altering the output of generators in both areas.

A number of studies have shown that combining balancing areas, or at least coordinating their operation, makes it significantly easier to reliably operate the electric grid, both with renewable energy and without. Larger balancing areas provide more opportunities for generation shortfalls in one region to be offset by excess generation in another region. This is particularly beneficial for wind and solar energy, for if the wind slows or clouds cover the sun in one area, electric output from other areas can make up for the loss.[18] The grid operator in the Midwest is in the process of consolidating its 26 operating areas into a single balancing area after calculating that this step would save $113-208 million in operating costs annually, exceeding the annualized cost of making the transition by a factor of 3.7 to 6.7.[19]

Even without full balancing area consolidation, which some of those balancing area operators resist, innovative solutions such as Area Control Error Diversity Interchange (ADI) can allow power to flow from balancing areas with excess generation to areas with shortfalls. Removing arbitrary restrictions on power flows will become even more beneficial as new transmission infrastructure is built, as a more robust interstate grid will allow greater amounts of electricity to flow from region to region.

Another highly cost-effective reform is the transition to more flexible procedures for scheduling power plant operations. In much of the country, power plants are scheduled to produce power in hourly blocks. As a result, the often rapid and significant changes in electricity supply and demand between these hourly intervals, which occur as millions of people turn air conditioners and other appliances on and off or as power plants experience failures and go offline, must be accommodated through the use of potentially expensive reserve generation. Because the output of wind and solar plants can vary significantly over the course of an hour, these power sources tend to further increase the within-hour variability of electricity supply. Instead of using expensive reserve generation to accommodate intra-hour variability in supply and demand, a much more efficient solution is to accommodate these variations by scheduling power plants to operate for 10-minute or even 5-minute blocks. Grid operators in California schedule power plant output in 5-minute blocks, which a 2007 study found drastically reduces the cost of integrating wind and solar power with the state's grid.[20] In addition, the lack of uniform scheduling intervals among grid operators in a region can significantly impair coordinated regional operations.

Scheduling procedures and markets that reward flexibility can also facilitate the integration of wind and solar energy by ensuring that flexibility is provided at the lowest possible cost. This can be particularly valuable in regions where the grid has limited flexibility. For example, the flexibility of the hydroelectric system on the Columbia River in the Pacific Northwest is becoming more constrained and is creating a demand for additional flexible energy solutions to complement the variability of wind. Potential resources to provide this flexibility include additional demand response, gas-fired peaking units, new hydropower at existing non-hydroelectric dams, and closed-loop pumped storage.[21]

Innovative transmission services are another way to more efficiently use the grid. Although the U.S. electric grid is highly congested when electricity demand is near its peak, the majority of the time only a fraction of available transmission capacity is used. Fortuitously, wind plants tend to produce the most electricity during these off-peak times. As a result, there are significant opportunities for wind plants and other renewable energy facilities to use spare transmission capacity outside of peak times. FERC has recently taken strong steps to encourage transmission operators to offer such opportunities, such as conditional firm service and redispatch service, and these efforts should be expanded. In addition, pumped storage hydroelectric plants are a transmission tool that can help balance load flow on the existing transmission system and can store wind energy at times of low demand. Because solar energy output tends to be highest during peak demand hours, there is less opportunity for using transmission capacity that is available during off-peak hours. However, many concentrating solar power plants can be readily coupled with thermal storage facilities that allow excess energy to be stored and used on demand, even overnight.

Finally, many grid operators assume that transmission lines have a fixed power transfer capacity year-round, typically based on their capacity during the hottest summer months and the assumption that there is minimal wind cooling the transmission line. However, the transfer capability of a line is often higher under lower ambient temperatures or when there is wind cooling the line. If power lines were dynamically rated to account for ambient weather conditions, more electricity could be transmitted over the line when wind and temperature conditions are more favorable than the assumed worst case.

Areas with Regional Transmission Organizations (RTOs) generally have been more effective at adopting coordinated regional grid operations through the use of large balancing areas, fast scheduling intervals, and energy markets. However, areas that currently lack RTOs also have many means of adopting these functions with or without new regional institutions.

IV. Consumer Benefits of Transmission

Any major investment in infrastructure may cause some "sticker shock," and transmission is no exception. Despite the seemingly high price tag of a transmission line, those costs are shared among many consumers over several decades, so the immediate rate impact is minimal. Fortunately, investments in transmission often yield economic savings for consumers that are larger than the cost of the transmission investment. Consequently, investments in transmission can more than pay for themselves, but only if the proper policies are in place. As Sections VI and VIII of this paper explain, the most important step the government can take to foster the construction of transmission is to create the right kind of policy environment. Before discussing these policies, however, it is important to review in more detail how consumers will benefit from an investment in transmission.

Most importantly, a robust transmission grid provides consumers with access to lower-cost electricity. On a severely constrained transmission grid, as we currently have in many parts of the U.S., consumers are forced to rely on local power plants even though plants in other regions can produce power more efficiently and at lower cost. For example, because of transmission constraints, consumers in New York and New England are forced to buy much of their electricity from older and less efficient power plants, some of them oil-fired, that are located within the region. Lower-cost energy resources surround the region, with abundant hydroelectric and other renewable resources to the north in Canada, northern New England, and upstate New York. However, imports into the region are limited because of severe constraints on the grid, so consumers must rely on inefficient local power plants for a significant amount of their electricity.

Partially as a result, average retail electricity prices in New York and New England are almost 15 cents per kilowatt-hour (kWh), 67 percent higher than the national average of 8.9 cents per kWh.[22] This price premium above the national average amounts to a $1.6 billion annual cost to consumers in the region. Similarly, the JCSP study found that under a reference case with 5% wind penetration, transmission congestion would cost consumers in the Eastern U.S. $16.5 billion per year in the form of higher electricity prices alone – more than enough to pay for the transmission needed to eliminate the higher prices.[23] Table 1 shows these annual congestion costs by region.

TABLE 1: **Costs of Transmission Congestion by Region in the Eastern U.S.**

Region	Upper Midwest	Great Lakes/ Mid-Atlantic	New England	Southeast	New York	Lower Plains
Annual Congestion Cost	$1.3billion	$2.6 billion	$2.8 billion	$4.8 billion	$3.7 billion	$1.2 billion

Source: Joint Coordinated System Plan Study

The effect of higher electricity prices goes beyond financial hardship for residential consumers. Businesses must pass higher electricity costs on to their customers, and electricity-intensive industries have a strong incentive to relocate to regions with lower electricity costs, taking jobs with them.

In contrast, the construction of transmission infrastructure itself can be a significant source of jobs and economic development for a region, often supplemented by the jobs and economic development created by the construction of new power plants along those transmission lines. New transmission infrastructure is also likely to significantly improve electric reliability in communities where it is deployed, a benefit for existing electricity users as well as a major point of attraction for high-tech industries and other sources of employment that rely on high power quality. Local landowners also typically receive easement payments for the use of their property as right-of-way for a transmission line, and for many landowners these payments can be a significant source of revenue.

Transmission infrastructure is also a powerful tool for increasing competition in wholesale power markets and reducing the potential for generators to exercise market power. Just as consumers in a region without high quality roads to other regions and a single retailer would be at the mercy of the prices charged by that retailer, a weak grid makes it possible for generation owners in constrained sections of the grid to raise prices beyond what they would be in a competitive market. In addition, a more robust transmission grid will create strong incentives for generators to reduce the use of old, inefficient power plants, as they would be unable to compete with modern, more efficient power plants that could import their power over a less-constrained grid.

A more robust transmission grid increases the efficiency of the electric grid in other ways as well. Electricity demand is heavily influenced by local weather, since a large share of demand is driven by air conditioning load in warmer regions and by heating load in colder regions. In addition, a significant share of total power system costs are driven by the investment in generating capacity that is needed to meet peak electricity demand, which almost always occurs during the few hottest or coldest hours of the year. Because weather is likely to vary significantly across regions at any point in time, peak demand in one region is unlikely to occur simultaneously with peak demand in every other region.

As a result, inter-regional power flows, enabled by a robust transmission grid, can significantly reduce the need for investment in generating capacity by allowing power to be imported from regions that are not simultaneously experiencing peak demand. The potential for electricity demand smoothing between winter-peaking power systems in colder climates and summer-peaking systems in warmer climates, using north-south power flows, is also quite significant. For example, the high-voltage Pacific Intertie transmission lines allow large power flows between the Pacific Northwest and California, making it possible for California generation to help meet the Northwest's peak demand during the winter and Pacific Northwest generators to help meet California's peak demand during the summer. They also blend the Pacific Northwest's primarily hydroelectric-based systems with California's primarily thermal generation-based systems. Green power superhighways would expand this regional example to a national level for renewable power.

This geographic benefit of transmission is even more pronounced on power systems with a significant amount of wind and solar power, given that the output of these resources is heavily dependent on location-specific weather events. A number of peer-reviewed studies have documented that the aggregate output of wind and solar plants spread over a large geographic area is much less variable than the output of plants clustered into a small area. Thus, a more robust grid can significantly reduce the cost of integrating wind and solar power with the grid by allowing larger power flows between regions as well as making it possible to access renewable resources from a greater diversity of areas.

Transmission is also an important mechanism to protect consumers against volatility in the price of fuels. As the New York and New England example illustrates, consumers in the region have had no choice but to continue using oil-fired generation to meet some of their power needs, even as the price of oil has gone up by a factor of five. Similar fluctuations in the price of natural gas and coal have led to drastic increases in the price of electricity for consumers in other regions. Between 1998 and 2006, consumers in Texas saw their electric bills grow from 7.6 cents per kWh to 12.9 cents per kWh as the price of natural gas, which provides half of the state's electricity, tripled. As a result, the average Texas household now spends $750 more per year on its electric bills. Similarly, consumers in the Eastern U.S. are now facing massive increases in their electric bills as the price of Appalachian coal, which accounts for a sizeable share of the electricity generation in the region, has tripled over the last year.[24]

Additional transmission capacity could have significantly alleviated the negative impact of these fuel price fluctuations on consumers by making it possible to buy power from other regions and move it efficiently on the grid. This increased flexibility would help to modulate swings in fuel prices, as utilities would be able to respond to price signals by decreasing use of the expensive fuel and instead importing cheaper power made from other sources.

Going forward, a robust transmission grid can provide valuable protection against a variety of uncertainties in the electricity market. Fluctuations in the price of fossil fuels are likely to continue, particularly if the electric sector becomes more reliant on natural gas. Further price risk associated with the potential enactment of policies that would establish a price for CO_2 emissions, in addition to uncertainty concerning the viability of technologies such as nuclear power and coal carbon capture and sequestration, place a greater premium on the flexibility and choice provided by a robust transmission grid. For regions where the quality of renewable energy resources is comparatively low, transmission is also important for ensuring that those regions have access to low-cost, zero-emission energy sources. Given that transmission infrastructure typically remains in service for 50 years or more, it is impossible to predict how fuel prices, policies and technologies will evolve over that time. As a result, all consumers should view transmission as a valuable hedge against uncertainty and future price fluctuations.

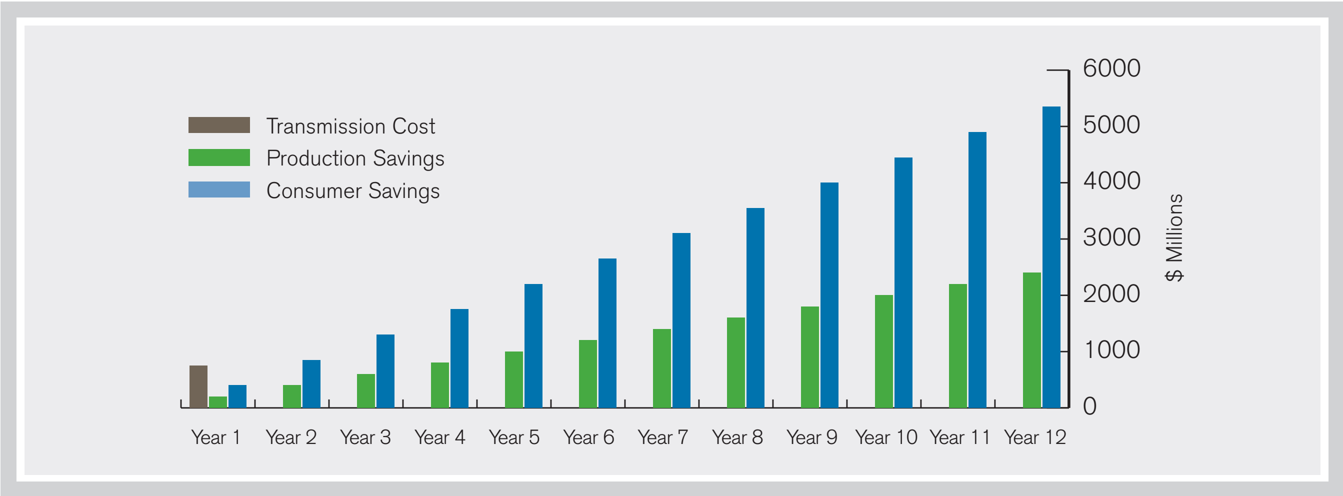
A stronger power grid will be more reliable, significantly reducing the immense cost of power outages for American consumers and businesses. The 2003 blackout in the Northeast U.S. and Canada caused an estimated $7-10 billion in economic losses.[25] A more robust grid is also important as a matter of national security, as it would be more resilient in the face of potential disruptions, both intentional and unintentional. A more robustly interconnected grid will provide a healthy redundancy in the event of the failure of a certain part of the grid, as well as allowing grid operators to respond more flexibly to emerging problems by bringing in generation from other regions.

In the context of the very substantial economic benefits of building a stronger grid, the cost of the transmission investments that will be required appear to be quite reasonable. The JCSP study found that an $80 billion investment in the transmission infrastructure needed to significantly reduce congestion and also integrate 240 GW of wind in the Eastern U.S. would produce enough benefits to pay for itself in seven years.[26] The AEP high-voltage transmission plan has an estimated price tag of $60 billion, though the analysis did not attempt to quantify the benefits of implementing the plan. Idaho National Laboratory recently released a study concluding that five proposed transmission lines in the Western U.S. would provide $55-85 billion in annual benefits, an amount many times larger than the cost of those lines.[27]

The cost of transmission infrastructure is typically very small compared to the savings and other benefits it produces. In the JCSP scenario discussed above, transmission would account for about 2 percent of total electric sector capital and operating costs between now and 2024. This finding is consistent with a number of other studies which have found that the costs of transmission account for a very small share of consumers' electric bills, about six percent on average.[28] Given that consumers will continue to reap the economic savings and other benefits of new transmission for the 50-year or longer life of the infrastructure, transmission is a wise investment.

Moreover, the benefits of transmission investment are often even larger when that transmission is built to access renewable resources. Renewable resources can be the lowest cost sources of electricity on the grid – and their fuel is free, so transmission that accesses renewable resources

FIGURE 3: **Results from Texas Study Show that Benefits of Transmission for Wind Exceed Costs**



(Source: Electric Reliability Council of Texas)

is very effective at reducing consumers' electric bills and the volatility of electricity prices.

A number of studies have found that the costs of transmission investments to integrate wind power and other renewables are significantly outweighed by the consumer savings that those investments produce. As illustrated in Figure 3, a 2006 study by the Electric Reliability Council of Texas (ERCOT) found that, over time, an investment in new transmission infrastructure for renewables would produce savings many times larger than the cost of the investment.

In 2008, ERCOT followed up with a more detailed analysis of the costs and benefits of potential transmission expansion plans to access renewable resources. The study found that the smallest transmission investment plan would bring enough new wind energy online to save $1.2 billion per year in fuel costs – enough savings to cover the $3.8 billion cost of the transmission infrastructure in a little over three years. The new wind brought online by the next largest transmission plan would save $1.7 billion per year in fuel costs, repaying the $4.9 billion cost of the investment in 2.9 years.[29] Given that the average Texas household saw their annual electric bill increase by $750 as the price of natural gas rose, spending a dollar or two more per month on transmission to access wind and limit the impact of future fuel price fluctuations is a prudent investment.

Similarly, a recent analysis by Charles River Associates, International found that an investment in a high-voltage transmission overlay to access wind resources in Kansas, Oklahoma and Texas would provide an economic savings of around $1 billion per year, more than twice the $400-500 million annual cost of the transmission investment.[30] $100 million of these savings come from the significantly higher efficiency of high-voltage transmission, which would reduce electricity losses by 1,600 gigawatt-hours (GWh) each year. The new transmission infrastructure would bring 14,000 MW of new wind plants online, reducing CO_2 emissions by 30 million tons per year. The overall wind and transmission project would also create 5,000 new permanent jobs, $60 million in annual property tax revenue, and $500 million in economic activity each year. As this study indicates, building transmission to access renewable resources can be a powerful driver for a region's economy.

Finally, the DOE's 20 percent wind analysis found that the cost of the wind scenario, including the cost of wind and transmission infrastructure, would be $43 billion higher than a scenario without wind energy, a difference of about 2 percent.[31] If one factors in the $150 billion in consumer savings from reduced natural gas use, plus the other economic development and environmental benefits of obtaining 20 percent of the country's electricity from wind energy, the investment easily pays for itself many times over.

V. Land Use and Wildlife Impacts

Transmission, like all infrastructure development, has the potential to result in habitat fragmentation and other land and wildlife impacts. It is important to plan over the long term to minimize these impacts. As explained in Figure 2, high-capacity transmission lines reduce land use significantly relative to lower-voltage lines, with particular benefits resulting from the consolidation of up to six transmission corridors into a single line. It is also extremely difficult to gain community support for the development of an additional transmission line shortly after an initial line has been built. Plans should be made, therefore, to seek a long-term optimum transmission capacity from the start.

Transmission planners can seek to locate renewable generation and transmission projects close to existing corridors or in developed, fragmented, or otherwise low-value wildlife habitat before considering unfragmented or high-value public lands.[32] Planners and developers can adopt best-management practices in areas deemed acceptable for development. Habitat fragmentation, soil impacts, vegetation disturbance, visual and noise impacts and specific threats to migratory and ground-nesting birds and other species can be considered at the earliest stages of planning to minimize impacts.

While greenfield construction of transmission certainly will be needed, any policy changes related to transmission should create very strong incentives and requirements to use existing transmission facilities and existing rights-of-way to rebuild new transmission as part of the green power superhighways when practical.

VI. Barriers

Given that the benefits of transmission easily exceed its costs, one may wonder why more private firms have not stepped forward to invest in transmission infrastructure. The crux of the problem is that most of the benefits of transmission are not adequately accounted for in the incentive structure offered to transmission investors. In other words, companies have no economic incentive to invest in transmission that will make consumers and society as a whole better off if the investment will provide them with little financial return.

The full benefits of transmission are not captured in the current incentive structure for several reasons. Much of the problem is that regulators and other policymakers who calculate the costs and benefits of transmission do so with a narrow geographic and chronological scope. State regulators, who in many areas have primary jurisdiction over what transmission gets built and who pays for it, are often required to weigh only the benefits of transmission investment that will accrue to residents of that state. Because the benefits of high-voltage transmission infrastructure typically accrue to millions of consumers over broad inter-state regions, this process effectively ignores a major portion of these benefits. Under this regulatory structure it is almost impossible to build an interstate transmission network. Most state regulators have little authority or incentive to require ratepayers in their state to help pay for an interstate network with regional benefits.

Similarly, most transmission planning and cost allocation is done with a focus on benefits that will be realized within five years, so benefits that are realized five years or more in the future are often ignored in the decision calculus. The result of using a narrow chronological and geographic scope to evaluate the benefits of transmission lines is that the transmission lines which are planned and built are smaller than they should be. As a result, the significant economies of scale and other benefits that come from a high-voltage transmission network are not realized. Instead of an efficient, high-volume interstate system, we are left with an inefficient and congested patchwork of local and state highways. Also, new lines and rights-of-way that would not have been necessary had high-capacity lines initially been built cause undue environmental harm.

Moreover, the significant mismatch between the amount of time needed to install a wind or solar plant and the time required to build transmission creates unique barriers to connecting renewable energy plants to the grid. A typical transmission line takes five years or more to be planned and built, while a renewable power plant can be constructed in less than a year. Transmission developers are hesitant to build transmission to a region without certainty that a power plant will be built to use the line, just as wind and solar developers are hesitant to build a power plant without certainty that a transmission line will be built. The waiting game that results from this uncertainty about which will come first, transmission or generation, is commonly referred to as "the chicken and egg problem." This has created an unsustainable situation where the decision to build transmission is being driven by individual projects on a transactional basis, rather than transmission being planned and built on a strategic basis to create renewable energy markets. The result is that transmission queues are long and the line is not moving.

Another major obstacle to transmission is that regulators in a single state can effectively veto a multi-state transmission network by refusing to grant the permits needed for siting a transmission line if they feel that their state would not receive an adequate share of the benefits. This siting problem is compounded by the overlapping patchwork of federal, state, and local regulatory rules that apply to the construction of transmission projects in many regions of the country. In particular, transmission lines that cross federal lands controlled by different federal agencies will be subject to the regulatory process of each of those entities. This is a major problem in the Western U.S., where the Department of the Interior, the Department of Agriculture, the Department of Defense and other federal agencies control more than half of all land.[33] Many of these federal regulatory entities have lengthy backlogs of applications to use their lands, so a proposed project that has cleared all other regulatory hurdles may be held up for years waiting for a permit from a single agency.

The current regulatory environment creates a free rider problem as well. The common regulatory framework of "cost causer pays" requires generators seeking to connect to the electric grid to pay for the full cost of upgrades to the grid network, even though the majority of the benefits of these upgrades would accrue to electricity consumers spread across a broad region and competitors that could piggyback on this investment. In many instances, interconnection studies indicate that adding a new power plant would overload transformers and transmission lines hundreds of miles away. Under the current regulatory framework, for that power plant to be built, its owner must pay to upgrade all of the transmission equipment, often at a cost approaching or exceeding the cost of the power plant itself. The generator is not given credit for reducing overall congestion or reducing customers' electricity prices. As a result, potential investors in transmission infrastructure have a strong incentive to let others pay for the upgrades, with the result being that no one steps forward to build the transmission. An analogous situation for the highway system would be requiring the next car on the on-ramp to a crowded highway to pay for the full cost of adding another lane to the highway, which is clearly not a workable process to pay for upgrades that would benefit all system users.

Similar policy obstacles also prevent a move to greater regional and inter-regional coordination of grid operations. The patchwork of balancing areas and utilities that are governed by different regulators and overseers results in a reluctance to coordinate operations. There is a desire for local control of functions like dispatching generation, in part because whoever controls which generators operate maintains some power over the market. As a result, there is a need for direct federal leadership to promote coordinated regional grid operation.

The root of all of these infrastructure and operations problems is that the policy and regulatory structure that governs the transmission industry is obsolete for today's electric industry needs. Many of these transmission policies are relics of the era when utilities primarily served customers in their state using generation in that state, so there was little need for strong transmission links to other states. As a result, the system of having regulators in each state evaluate transmission proposals based on benefits to that state alone worked adequately in that business environment.

With the expansion of competition in wholesale electricity markets in the last decade, electricity is increasingly sold across state lines and balancing area interconnections. But the regulatory environment for transmission investment has not kept pace with this change in market structure. The result has been sustained underinvestment in an increasingly congested transmission grid that is now being used to move power in ways that it was not designed to accommodate. In the Eastern U.S., requests for loading relief to reduce congestion on the grid have tripled since 2001, and 70 percent of the country's transmission infrastructure is now 25 years or older.[34] As one would expect, a balkanized patchwork of regulations has produced a balkanized patchwork of an electric grid.

VII. Experts Agree: Transmission Is Essential in Addressing Economic, Energy, and Climate Challenges

A growing chorus of experts and leaders from across the political spectrum, ranging from President Barack Obama to former Vice President Al Gore to oil magnate T. Boone Pickens, has united in calling for new transmission policy out of concern that the current grid will present an obstacle to the deployment and integration of low-carbon energy technologies.

When asked in the first Presidential debate what policy priorities he would keep despite mounting fiscal pressures, then-candidate Barack Obama listed "making sure that we have a new electricity grid to get the alternative energy to population centers" as one of his top priorities.[35] President Obama expanded on this thought in an interview on MSNBC just before the election, noting that:

> One of … the most important infrastructure projects that we need is a whole new electricity grid. Because if we're going to be serious about renewable energy, I want to be able to get wind power from North Dakota to population centers like Chicago.[36]

Vice President Joe Biden has also explained his view that an investment in transmission infrastructure would stimulate the economy while at the same time helping to solve America's long-term energy and climate challenges:

> Anything we put in this economic recovery plan has to be designed to create jobs, to stimulate the economy quickly, get jobs moving quickly. And it has to be for something that has a long-range impact on our economic health. Case in point, we want to spend a fair amount of money investing in a new smart grid. That is, the ability to transmit across high-tension wires in the minds of most people in the public, or underground in these wires, wind and solar energy. You can't do that now. That would create tens of thousands of new jobs, high-paying jobs. It needs to be done and it will have a long-range payoff not just for next year and the following year, keeping the economy from nose-diving, begin to turn the nose of that aircraft up, but it will also change our energy picture. It will deal with global warming.[37]

Former Vice President Al Gore, speaking in Washington, DC, on July 17, 2008, also articulated the vision of a more robust grid:

> We do not have a unified national grid that is sufficiently advanced to link the areas where the sun shines and the wind blows to the cities in the East and the West that need the electricity. Our national electric grid is critical infrastructure, as vital to the health and security of our economy as our highways and telecommunication networks. Today, our grids are antiquated, fragile, and vulnerable to cascading failure. Power outages and defects in the current grid system cost U.S. businesses more than $120 billion dollars a year. It has to be upgraded anyway.[38]

MIT economist Paul Joskow, an expert on electricity markets, recently stated that transmission policy reforms similar to the ones proposed in this paper are essential to achieving cost-effective reductions in CO_2 emissions:

> The organizational and regulatory framework that presently governs much of the U.S. electric power sector is not conducive to supporting these transmission investments. If remote sources of renewable energy are not available to meet state or potential future federal renewable energy portfolio standards or to respond to the incentives provided by CO_2 emissions prices, CO_2 mitigation goals will be even more costly to achieve.[39]

T. Boone Pickens, a Texas oil magnate, has also called for federal legislation to implement significant changes to cost allocation and siting policies. As he testified at a Senate hearing on renewable energy and transmission, these reforms are important because:

> In order for renewables to replace a meaningful amount of our imported oil, we need a national electricity transmission system to carry this electricity, be it wind, solar, biomass or other alternatives.[40]

Richard Sergel, President and CEO of the North American Electric Reliability Corporation (NERC), the organization charged with maintaining the reliability of the electric grid in North America, expressed similar concerns:

> We're sitting on the precipice of climate change legislation...It is in that context that we believe that the grid will be threatened unless we build the transmission infrastructure that is necessary to support renewable resources like wind, that will enable us to locate new clean coal facilities — or even the gas facilities — to locate them in places in which the grid will be able to withstand that so that we can meet the load requirements as they grow and have a reliable system for the operators to deal with… It doesn't matter if it's going to be the clean coal plant or the nuclear plant or the wind project or the solar project. The common denominator is that they are going to require transmission to move [electricity] from where it is [generated] toward the load centers.

In November 2008, NERC released a report that reached similar conclusions, noting that "The ability to reduce the carbon emissions of the electric sector hinges on having a robust transmission system." The report went on to endorse changes to planning and cost allocation procedures very much in line with the policy proposals outlined above, arguing that "Ensuring a suitable transmission system will require a two-pronged approach: building new infrastructure and changing current planning mechanisms to focus more heavily on interregional and continent-wide planning and operation. For example, cost allocation issues need to be resolved in order to develop meaningful, continent-wide planning processes as this influences how planning is conducted."[41]

It is highly encouraging that political leaders and experts are aware that the grid's limitations pose a serious obstacle to addressing our nation's energy and climate problems, although this awareness must be converted into action. Given that the process of planning, permitting, and building transmission lines can take five to ten years or more, a failure to make transmission policy reform a priority will seriously limit our country's ability to address the problems of climate change and energy security in a timely and cost-effective manner.

VIII. Policy Solutions

To meet renewable portfolio standards, greenhouse gas reduction goals, and the public's demand for clean energy sources, a major investment in new transmission infrastructure is needed. Maintaining today's policies will result in a continuation of the slow and fractured development of transmission emblematic of the past few decades. It will result in only small, incremental amounts of new renewable generation resources. The status quo will also result in transmission lines that are undersized for what is needed in the long term. Worse, it will cost significantly more to develop transmission under the existing antiquated regulatory framework, and we will get less for it. Transmission is not an alternative to energy efficiency, demand response, and distributed generation; rather, all of these measures are needed to meet the nation's climate change and energy independence goals.

There are a number of steps that can be taken within existing legal authorities to develop transmission and it is important to recognize the early efforts of many entities in moving interstate transmission plans forward.[42] It is important to note that these efforts would have little chance for success without the constructive input and cooperation of the environmental community which generally recognizes the emissions benefits that transmission can enable if used to deliver renewable energy.

While these positive attempts to develop transmission by utilities, regulators, and state and federal entities can approximately double the amount of renewable electricity provided, the nation needs to develop much more than that. To do so, significant structural barriers must be addressed. Federal leadership from the President and Congress will be required to pass legislation and provide new mission statements, adequate resources and specific timelines for action for federal agencies, such as FERC, DOE, and federal lands agencies.

The core elements of these changes are interconnection-wide transmission planning, interconnection-wide transmission cost allocation and certainty of cost recovery, and streamlined siting.[43] This regulatory structure would apply only to new extra-high-voltage transmission lines and renewable energy feeder lines, leaving intact much of the existing regulatory jurisdiction and preserving transmission rights of current grid users.

INTERCONNECTION-WIDE TRANSMISSION PLANNING

The first step in building green power superhighways is to develop a comprehensive plan. To that end, the Western Interconnection and the Eastern Interconnection should each develop regional transmission plans that identify where new transmission lines (or increased transmission capacity on existing lines) are necessary to connect renewable energy resources to the grid and, ultimately, to load centers.[44] These plans should include both extra-high-voltage transmission lines and the lower-voltage feeder lines that are necessary to facilitate the development of green power superhighways. An interconnection-wide planning entity should assist in the development of these plans. Congress should provide FERC with adequate authority to establish a process for the development of these plans. FERC would approve the plans if they are in the public interest and meet other criteria required by the new law.

The planning process should be informed by governors, public utility commissions, and other regulatory bodies in the affected states in an interconnection. These governmental entities are valuable partners in the planning process and can provide expert insight and advice on how an interconnection-wide plan could help their states meet their environmental, energy policy, and economic development goals. The process should also be open and transparent, to allow affected stakeholders to express their views.

Integrating renewable energy generation into the grid should be the primary planning criterion of that planning process, but plans should also promote reliability, reduce costly transmission congestion, and integrate other resources that are necessary to support the grid. Plans should expressly take into account established state and federal renewable energy requirements and changes in generation and demand pattern shifts resulting from greenhouse gas policies. A long-term planning time horizon – beyond the 10-year period typically used today – should be employed.[45] The plans should be consistent with policies designed to safeguard sensitive lands and protect the environment and solicit input on sensitive areas that should be avoided. To minimize environmental impact, plans should utilize existing transmission corridors whenever possible. Finally, the various regional planning efforts that are already underway ought to be incorporated into their respective interconnection-wide plans.

INTERCONNECTION-WIDE TRANSMISSION COST ALLOCATION AND CERTAINTY FOR COST RECOVERY

Ratemaking and cost recovery certainty should be provided to address perhaps the most important barrier to transmission development, the question of who should pay. The current process of assigning costs to specific users who volunteer to pay does not work. That only exacerbates the free rider problem where users attempt to shift costs onto others. Since all users benefit from a robust transmission grid, regulatory policies must reflect that. Facilities identified in the interconnection-wide plan as necessary for the development of green power superhighways should be eligible for broad, regional cost allocation. Specifically, FERC should allocate, based on electricity usage, the capital and operating costs of these transmission lines across all load-serving entities on an interconnection-wide basis. In regulatory terms, the "determination of need" would be made in the regional plan, approved by FERC.

FEDERAL SITING

When making a siting determination, many states can only consider the economic and reliability benefits that accrue within their state borders from proposed transmission projects, rather than regional or national benefits. While some states have begun to recognize regional benefits in their consideration of such certificates for transmission development and have incorporated those changes into their regulatory policies, there are significant structural limitations that impose a ceiling on the amount of transmission that is reasonable to expect.

To achieve dramatic increases in renewable electricity production, substantial reform of the transmission siting process is required. The most effective model for siting is the full siting authority that is given to FERC over interstate natural gas pipelines. For green power superhighways, the extra-high-voltage facilities defined in the regional plans would be subject to FERC approval and permitting. Separate siting approval at the state level would not be required. FERC would act as the lead agency for purposes of coordinating all applicable federal authorizations and environmental reviews with other affected agencies. As is the case for natural gas pipeline and hydroelectric facility permitting, FERC would be required to consider siting constraints based on habitat protection, environmental considerations, and cultural site protections identified by state agencies. While the concept of federal siting authority for electric transmission has been controversial in the past, the issues raised in this paper demonstrate that a new era is upon us. The infrastructure required to serve future electricity needs requires a new approach and justifies giving FERC exclusive authority for siting green power superhighways.

Short of exclusive FERC jurisdiction, one option is to institute a federal backstop role over siting. Very limited backstop siting was provided to FERC in the Energy Policy Act of 2005, for areas which DOE identifies as congestion corridors. However, there have been concerns with how the Department of Energy implemented this provision. There are also flaws in the legislation. It provides for federal siting authority if a state withholds approval but courts are currently deciding whether a state denial constitutes such a withholding. The provision also does not provide federal authority over state-owned lands, and a state can purchase land to prevent federal authority from being exercised. The authority is not limited to renewable energy and in fact does not even list renewable energy specifically as a criterion for corridor designation. Finally, many states require a transmission project developer to be a public utility in the state – a determination that is up to states – and the act does not address this. These deficiencies would need to be rectified to make any federal backstop siting authority workable.

Access to Green Power Superhighways

Renewable generators should be given first priority for interconnecting to and long-term capacity rights on green power superhighways, to the extent those are operationally feasible.

Power Marketing Administrations

The nation's Power Marketing Administrations and the Tennessee Valley Authority (collectively, "PMAs") should develop, to the maximum extent possible, renewable resources within their footprints. Thus, the PMAs' charters should be revised to include the goal of developing renewable energy generation for use by their customers. PMAs should be partners in planning for and construction of green power superhighways. Apart from serving their own power needs, the PMAs could serve as backstop transmission owners if no utility or transmission company wants to step forward to build a critical element of a green power superhighway. To increase the PMAs' ability to integrate renewable energy resources and facilitate development of green power superhighways, changes to their current authorizations and funding are necessary. Specifically, the $100 million limitation on third-party contributions to the Western Area Power Administration and the Southwestern Power Administration for the development of transmission projects should be removed. PMAs should also be given the authority to borrow from the federal treasury to finance transmission projects within their footprints, and, in particular, Bonneville Power Administration's bonding authority should be increased to at least $10 billion.

Regional Grid Operations

In order to promote efficient and reliable means of integrating renewable energy resources into the existing grid, Congress should consider legislation that directs FERC to improve grid operation methods and structures. Specifically, FERC should be directed to promote contractual and operational arrangements that support greater use of variable resources, including the coordination of balancing areas through "virtual" balancing for all generation and load within a relevant area and faster scheduling and dispatch mechanisms, and better integration of demand response.

TIMEFRAMES

Because of reduction in greenhouse gas emissions goals, energy reliability and security demands, and the need for economic stimulus, we believe that clear goals must be set with firm deadlines. Though there are numerous tasks and details, we believe the following is a realistic high-level timeframe to bring the first phase of the nation's green power superhighways on-line:

- Pass necessary federal legislation and implement initial administrative actions.
- Within 60 days – Stakeholders begin regional plans for green power superhighways.
- Within 180 days – FERC completes a final rulemaking regarding cost allocation for green power superhighways.
- Within 6 months – Interconnection-wide planning entities complete regional plans for green power superhighways and submit to FERC for approval.
- One year later – FERC completes siting, permitting and other approvals for green power superhighways.
- Thereafter, regional plans for green power superhighways are updated on an annual basis.

IX. The Road Forward

In his inaugural address, President Obama framed the modernization of our electrical transmission grid as critical to our commerce and to our national well-being. To detractors who say that an effort like this is too bold, he said, "Their memories are short. For they have forgotten what this country has already done; what free men and women can achieve when imagination is joined to common purpose, and necessity to courage." Modernizing America's outdated transmission infrastructure will not be easy. It will require bold, forward-looking action from leaders who recognize that addressing America's economic, energy, and climate challenges must be a top priority in the coming years. All three challenges are intertwined. All three require new, innovative ways of thinking about energy policy at the local, state, and federal level. And all three will require a modern transmission system that is able to deliver clean, abundant renewable energy to homes and businesses efficiently and reliably. These are challenges that we can and must address now.

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[43] Note: In the continental U.S., there are three interconnections. One consists of most of the state of Texas. The Western Interconnection is the power grid generally west of the Rocky Mountains. The transmission grid east of the Rocky Mountains comprises the Eastern Interconnection.

[44] Note: Alaska, Hawaii, and Texas would be exempt from creating such transmission plans, as they are separate, single-state transmission systems and do not face the same challenges as areas where transmission lines cross state boundaries.

[45] Note: The 10-year horizon is common because transmission planners generally do not know where future generation will be located. That concern is alleviated for renewable generation, as the locations of resource-rich areas are well-documented.




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